基徵草蛉飼養技術研究及應用於友善環境農業

許北辰 [1]、董耀仁 [1]、楊婉秀 [1]、余志儒 [2*]

1 農委會農業試驗所應用動物組助理研究員。台灣 台中市。
2 農委會農業試驗所應用動物組副研究員。台灣 台中市。

摘要

基徵草蛉 [*Mallada basalis* (Walker)] 幼蟲又被稱為「蚜獅」，為多種小型害蟲的重要天敵，可利用人工飼料大量繁殖，於國內外溫網室皆有應用實例，為友善環境栽培體系極具應用潛力的天敵昆蟲。友善環境農業常面臨具有抗藥性的小型害蟲危害植株，然而在不使用化學合成農藥的情況下，若適當的搭配天敵昆蟲作為因應害蟲的策略，可適當降低使用非農藥資材之成本，並在成本與效率間尋得平衡。目前草蛉的研發工作，首要為研發省工飼育技術，並善用對環境及天敵昆蟲友善的防治資材，以擬定與友善防治資材互相搭配之設施多元蟲害防治策略。另尚需選育可耐極端氣候之草蛉品系，以滿足各農業生產區之氣候條件。將昆蟲天敵適當的融入友善農業環境的蟲害防治策略，並搭配合宜的防治資材，能在防治害蟲的同時，也盡到保護環境的責任。

關鍵詞：基徵草蛉、友善環境農業、害蟲綜合防治。

前言

安全農業為世界趨勢，更是重要的友善農業生產方式。以往慣行農業為追求高產量，使用化學合成農藥與肥料，對環境造成負面影響，且破壞自然界的生物多樣性，造成生態系失衡，以及許多物種消失 (Simpson *et al.* 2011a, 2011b)。為降低化學合成農藥對環境的破壞，在友善環境農業的害蟲綜合防治 (integrated pest management, IPM) 發展過程，如何妥善的運用生物天敵形成農業防治策略，已是友善農業的重要課題(So *et al.* 2004; Lu & Wang 2006; Chen *et al.* 2014; Xiu *et al.* 2017; Ye *et al.* 2017)。常被運用的天敵昆蟲包含瓢蟲、椿象、捕植蟎，以及草蛉等，本文所介紹的基徵草蛉，其飼養技術已經技轉廠商，可大量生產繁殖且有購買管道，有效防治農業上的小型害蟲，為一種重要的天敵昆蟲 (Wu 1995; Lu & Wang 2006; Hsu *et al.* 2020)。

基徵草蛉簡介

基徵草蛉 [green lacewing; *Mallada basalis* (Walker)] 屬脈翅目草蛉科 (Neuroptera: Chrysopidae)，英文俗名 green lacewing，其成蟲 (圖 1d) 為植食性，以花蜜、花粉等為食 (Wu 1995)。草蛉幼蟲又被稱為「蚜獅」(aphid lion) (圖 1 c)，顧名思義為蚜蟲的重要天敵。幼蟲除了會捕食蚜蟲，也對粉蝨、葉蟎等多種小型害蟲具有強大的捕食能力，是農業環境的重要天敵 (Lee 1994; Wu 1995; Lu & Wang 2006; Chang & Lu 2007; Chen *et al.* 2014; Hsu & Lu 2020)。基徵草蛉幼蟲可利用人工飼料大量繁殖 (圖 2 c) (Cohen 1983; Ma *et al.* 1986; Lee 1994; Ye *et al.* 2017; Hsu & Lu 2020)，應用於國內外溫網室的害蟲綜合防治，包括推薦施放於草莓、茄科和瓜類等作物，防治如棉蚜 (*Aphis gossypii* Glover)、銀葉粉蝨 (*Bemisia argentifolii* Bellows & Perring)、

*論文聯繫人
e-mail: jzyu@tari.gov.tw

潛葉蛾（*Phyllocnistis citrella* Stainton)、橘球粉介殼蟲（*Nipaecoccus filamentosus* Cockerell)、神澤氏葉蟎（*Tetranychus anzawai* Kishida）及二點葉蟎(*Tetranychus urticae* Koch)等重要害蟲（Wu 1992; Chang & Huang 1995; Wu 1995; Lu & Wang 2006; Cheng *et al.* 2010; Chen *et al.* 2014)。因此草蛉為友善環境栽培體系極具應用潛力的天敵昆蟲。

基徵草蛉產卵時會於腹部末端於基質表面產生一卵柄（egg stalk）構造，再將卵粒附著於物體表面，卵柄長約 6-8 mm，卵粒長約 0.9 mm，未孵化時為綠色（圖 2），孵化後卵殼呈現白色（圖 1a）。此卵柄之物理結構及氣味成分在卵孵化前可防禦如螞蟻等天敵，或降低同種間自殘的機率（Eisner *et al.* 1996)。草蛉幼蟲共三個齡期，頭部口器特化，形成兩根細長而且堅硬的彎管，可刺入獵物體內取食。剛孵化的幼蟲體型細小似螞蟻，體長約 1-2 mm，三齡幼蟲體長可達 6-8 mm，隨著成長發育，體型呈現頭尾兩端略尖，中段腹部粗大的紡錘型（Early 2019)。體色則隨著食物來源不同，呈現灰褐色並帶綠色或些微橘黃色。

基徵草蛉僅幼蟲期為肉食性，其幼蟲對於小體型的害蟲具有高度取食能力，因此在友善環境農業的害蟲防治策略中，具有重要的應用價值與潛力。

食餌技術為天敵量產與應用之重要關鍵

應用天敵的瓶頸主要為食餌量產，由於飼養捕食性天敵昆蟲需有穩定且持續的活餌供應，因此量產活餌是極耗費人力、時間和飼養空間的工作（Hsu & Lu 2020)。農試所發展之人工飼料及微膠囊飼料（圖 3）技術為基徵草蛉量產的重要技術突破（Cohen 1983; Ma *et al.* 1986; Lee 1994; Ye *et al.* 2017)，經調整既有的微膠囊飼料生產設備，微型化人工卵製程部分之動力器械，改善整體操作流程（圖3、表1），可降低機械成本，也大幅提升操作便利性，可穩定生產供應草蛉幼蟲成長所需的餌料（圖4），且提高餌料的包埋特性及品質均一性（圖5、表2），除了縮短草蛉於飼養過程中的生長時間、改善存活率，並可提高成蟲的產卵量（表3、表4、圖6) (Hsu & Lu 2020)。

基徵草蛉的量產技術目前除技術轉移給個體農戶，另亦技轉給天敵生產公司進行商業化生產草蛉卵片及幼蟲，提供農友和一般民眾購買作為田間防治及居家園藝用途。農戶若有人力也可自行生產繁殖草蛉並釋放卵片及幼蟲。

基徵草蛉應用研究

基徵草蛉的幼蟲期為肉食性，因此應用於蟲害防治時，以草蛉的幼蟲為主。由於草蛉卵被卵柄黏附於產卵標的上，較難快速的自產卵標的基質上分離 (Ridgway *et al.* 1970; Nordlund & Correa 1995a, 1995b; Nasreen *et al.* 2004; Sattar & Abro 2011; Hsu *et al.* 2020)，因此應用於葉菜類或瓜果類等作物時，可將黏附卵粒之卵片紙張拆解為小單張，再將紙張以鐵線、塑膠繩，或釘書針等懸掛於田間植株，待幼蟲孵化後便會自行於植株上爬行並取食害蟲（Lu & Wang 2006; Cheng *et al.* 2010; Chen *et al.* 2014)。以電動推剪搭配旋風離心器切斷草蛉卵柄並收獲草蛉卵粒（圖 7），與傳統次氯酸鈉法處理組相較，卵收獲率（90.2% ± 0.6% vs 80.0% ± 2.3%）、卵孵化率 (80.8% ± 2.8% vs 70.0% ± 3.6%）及成蟲獲得率 (54.2% ± 3.4% vs 46.7% ± 4.1%）皆以電動推剪搭配旋風離心器者較佳（表 5），且卵粒形狀完整（圖 8），以推剪搭配旋風離心器收獲草蛉卵粒具有速度快，器械體積小，操作便利，安全性高等優點，有應用於小型草蛉卵收獲系統之潛力（Hsu *et al.* 2020）。

由於小型害蟲昆蟲生活史短，且常群聚並躲藏於葉背，又對於化學農藥之抗藥性累積迅速，以致農藥噴施效果不彰。應用天敵於高經濟價值之果園或作物溫網室內進行蟲害防治，具有降低成本及減輕環境負荷等優點（Lu & Wang 2006; Cheng *et al.* 2010; Chen *et al.* 2014)。基徵草蛉的幼蟲不僅食性廣，對多種作物害蟲的捕食量也很大。其幼蟲至成蟲期可捕食超過自身體積百倍之小型害蟲，其中以三齡幼蟲捕食能力最強（Hsu & Lu 2020)，於實驗室條件下，一隻基徵草蛉在三齡幼蟲期可捕食近 500 粒外米綴蛾卵或 3000 餘隻銀葉粉蝨若蟲；而在東方甜瓜的植株上，每日可捕食 400 隻蚜蟲或 700 多隻銀葉粉蝨若蟲 (圖 9) (Hsu & Lu 2020)；應用於設施木瓜、甜椒及香草作物上防治小型害蟲時，在適當的天敵與害蟲比例下亦有 80%以上的蟲害防除率（表 6) (Chen *et al.*

2014; Lu & Wang 2005)。

天敵為友善環境農業害蟲防治的輔助角色

應用草蛉防治害蟲時，應於田間均勻釋放卵粒或幼蟲，並隨著害蟲密度的不同，調整釋放的天敵數量 (Wu 1995; Lu & Wang 2006; Cheng *et al.* 2010; Chen *et al.* 2014) 。防治蟲害的過程，除了以友善環境資材搭配昆蟲天敵使用，更應以預防性的思維，從蟲害入侵設施的源頭作處理，才能事半功倍 (Yu *et al.* 2017) 。當田間蟲害發生時，應用天敵便如同應用田間防治資材，必須持續使用及釋放到害蟲數量降低為止。以預防性施放的觀念而言，害蟲大發生前即進行施放為上策 (Simpson *et al.* 2011a, 2011b)，使田間保持穩定的天敵數量，如同守衛一般為農地及設施把關。

於農業設施環境中營造適當的天敵保育區，使天敵昆蟲願意長期留存於在田間且立足，除須要搭配環境溫溼度，尚須避免田間天敵如螞蟻，更需使害蟲與天敵在田間維持平衡，以壓低害蟲密度 (So *et al.* 2004; Xiu *et al.* 2017) 。由於農民常希望單獨依靠天敵將設施內的害蟲捕食殆盡，但是當害蟲數量降低，生物天敵便失去食物來源，進而遷移離去或是於原地互相殘殺。因此，在大量釋放天敵的場合，大部分的天敵吃完害蟲後，僅有少部分的天敵會於原地續留 (Xiu *et al.* 2017)。若欲誘使天敵於原地續留，除了要在田間營造一無環境汙染的棲身處，另需要有穩定的食物來源，譬如有蜜源植物作為成蟲食餌 (So *et al.* 2004)，像草蛉此類天敵才有機會長時間停留於特定區域，或是繁衍至下一代。

天敵應用於家庭園藝市場

基徵草蛉除應用於設施與溫網室的蔬菜、茄科及瓜類等作物外，農民也會應用基徵草蛉在自家的設施農園，包括茄子、白菜、萵苣、橄欖菜等蔬菜作物，苦瓜、絲瓜等瓜類，此外還有玫瑰和非洲菫等觀葉或花卉作物，以及草莓、木瓜等。近年來民眾風行於居家種植香草盆栽或花卉，當植株被蚜蟲、介殼蟲等小型害蟲入侵，造成植物黃化、衰老而需要進行害蟲防治時，由於香草盆栽通常都是自家飲茶使用，一般人多不願意噴灑農藥，甚至不願噴灑辣椒水、油劑類等防治資材。當嘗試各方作法無效後，便想試以天敵昆蟲進行害蟲防治，以避免在植物上噴灑防治藥劑，其中基徵草蛉由於較容易取得也有管道購買，便成了民眾心中的首選。民眾若能接受「以蟲治蟲」的概念，草蛉將是極具應用潛力的天敵昆蟲，並可強化廠商延伸發展居家盆栽的天敵昆蟲商品之意願。

未來展望

基徵草蛉由於開發大量飼育技術，且幼蟲對小體型害蟲之捕食量大，目前已有商業販售，農民可以有管道購買使用，預期可成為重要的友善農業天敵資材。運用時若能搭配適合的條件及策略，將可發揮最大的功用，目前基徵草蛉的研發重點，首要為開發省工的飼育技術，並善用對環境及天敵昆蟲友善的防治資材，擬定更多元的應用於設施及園藝害蟲防治之策略 (Hsu & Lu 2020)。另一方面，由於飼養草蛉時的卵粒收集工作費時，且受限於先天卵柄結構消耗運送空間 (Bezerra *et al.* 2014; Hsu *et al.* 2020)，因此開發快速省工且自動化之取卵方式，也是重要發展方向 (Ridgway *et al.* 1970; Nordlund & Correa 1995a, 1995b; Nasreen *et al.* 2004; Sattar & Abro 2011; Hsu *et al.* 2020)。

尤其是選育耐極端氣候之品系，由於基徵草蛉的環境分佈仰賴適合的生存溫度，一般約為 26-28℃ (Cheng *et al.* 2012; Hsu *et al.* 2020)，但台灣平地農業設施於夏季常處高溫，而高海拔之農業環境於春秋兩季常為冷涼氣候，若應用草蛉於過熱或過冷之環境溫度，將會阻礙其生長發育 (圖 10)，且會降低草蛉幼蟲之取食意願，影響對蟲害的防治效率 (Lu & Su 2005)。有鑑於商業上之昆蟲物種，如家蠶 (Bombyx *mori*) 已有數種耐溫之商業品系，可滿足各絲線生產區之氣候條件，因此選育可忍耐極端氣候之草蛉品系，乃為未來重要的發展方向 (Manjunatha *et al.* 2010)。

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圖 1、基徵草蛉（*Mallada basalis*）的卵（a）、取食微膠囊飼料的幼蟲（b）、補食花胡瓜（*Cucumis sativus*）葉片上之棉蚜（*Aphis gossypii*）的幼蟲（c），以及成蟲（d）。

Fig. 1. The eggs of green lacewing (*Mallada basalis*) (a), the larvae of green lacewing feed on the cotton aphid (*Aphis gossypii*) on the cucumber (*Cucumis sativus*) leaves (b), the larvae of green lacewing feed on microencapsulated feed (c), and the adults of green lacewing (d).

圖 2. 基徵草蛉(*Mallada basalis*)卵粒藉由卵柄附著於平面。

Fig. 2. The eggs of *Mallada basalis* are attached to the plane by the egg stalk.

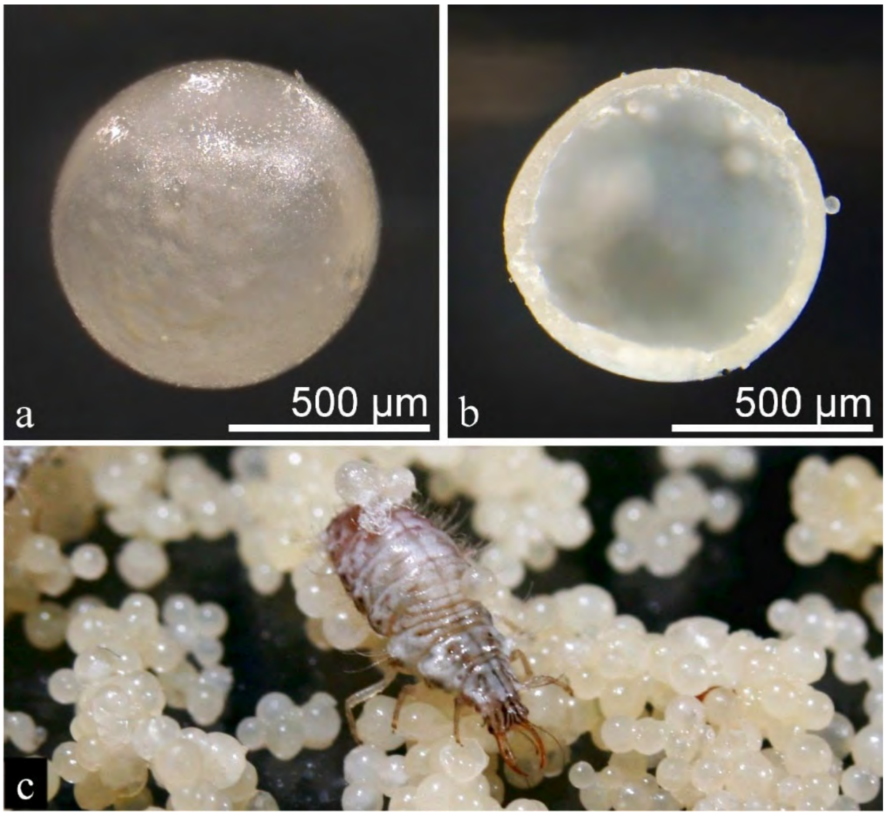

圖 3. 用於飼養基徵草蛉（*Mallada basalis*）之微膠囊飼料的前視圖（a）及剖面圖（b)。以及正在取食飼料之基徵草蛉幼蟲（c)。此微膠囊飼料之表面蠟層形成一種可輕易被基徵草蛉幼蟲大顎刺穿之核-殼結構。

Fig. 3. Front (a) and sectional view (b) of the new microcapsule diet. The green lacewing (*Mallada basalis*) larva feeding upon and collecting spherical microcapsules (c). This microcapsule diet was wax coated

to form the core–shell structure and could be easily pierced by *Mallada basalis* larval mandibles.

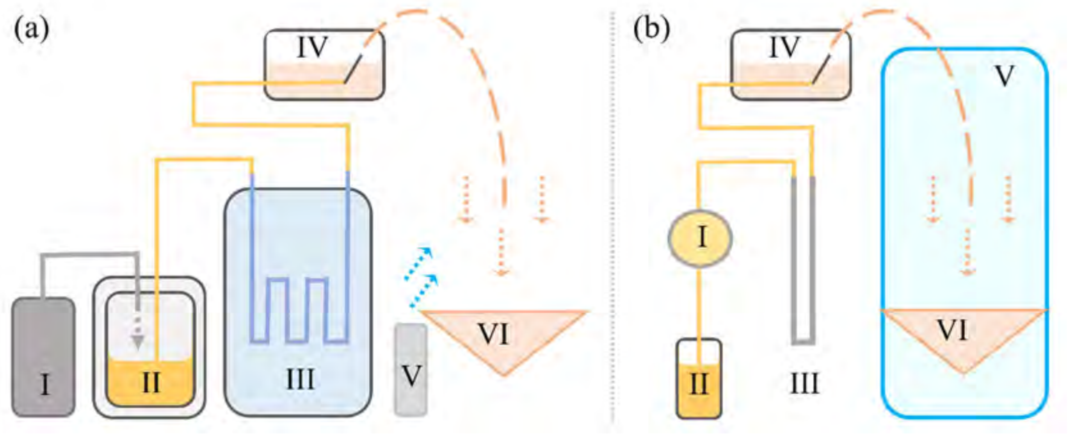

圖 4. 兩種微膠囊製程之比較。原製程 (a)，飼料先儲存於壓力槽 (II) 並藉由空氣壓縮機 (I) 推擠經過水浴機 (III) 至蠟盤 (IV) 最後噴射於冷卻區 (V) 並集中進入收集槽 (VI)。新製程 (b)，飼料先預存於容器 (I) 並由泵浦 (II) 擠壓至熱的不鏽鋼管 (III)，並且於密閉空間降溫 (V)，集中進入收集槽 (VI)。此程序生產之蠟殼微膠囊飼料可用於飼養基徵草蛉 (*Mallada basalis*)。

Fig. 4. Diagrams of both encapsulation processes. In the old process (a), the diet is loaded in a pressure can (II) and driven by an air compressor (I) through a water bath (III) and wax plate (IV), and is finally sprayed onto the cooling area (V) and collected in the harvester (VI). Diet of the new process (b) is loaded in a stock container (I) and driven by a pump (II) through a heated stainless tube (III) and is finally cooled in a sealed chamber (V) and collected in the harvester (VI). This process was used in this study to produce the wax-shell-based core–shell microcapsule diet for rearing *Mallada basalis*.

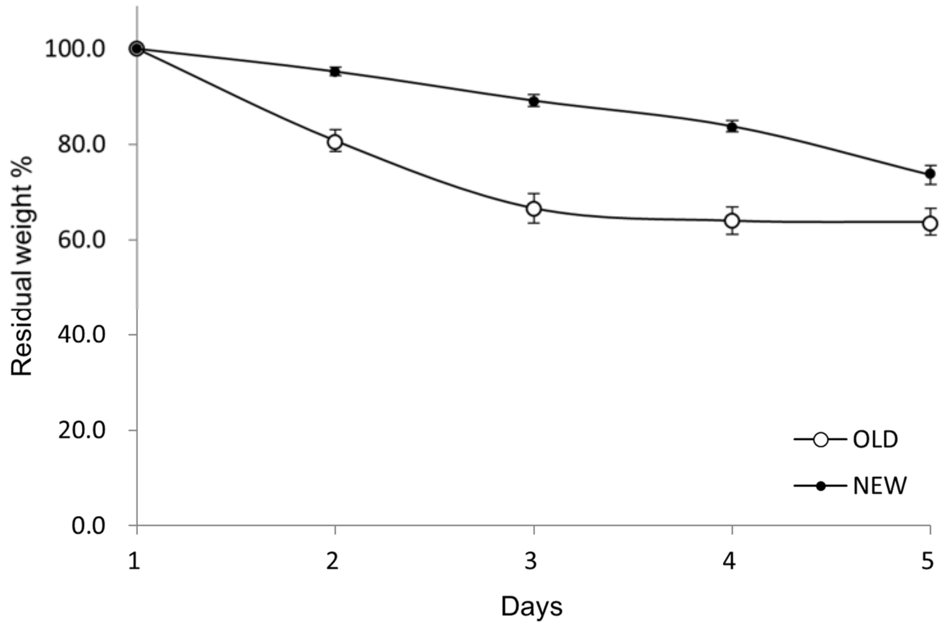

圖 5. 用於飼養基徵草蛉 (*Mallada basalis*)之微膠囊飼料，於幼蟲飼養盒中放置 5 天後之平均剩餘重量。

Fig. 5. Mean (±SE) weight of the old and new microcapsules five days after placing the microcapsules

into a larval rearing cage of *Mallada basalis*.

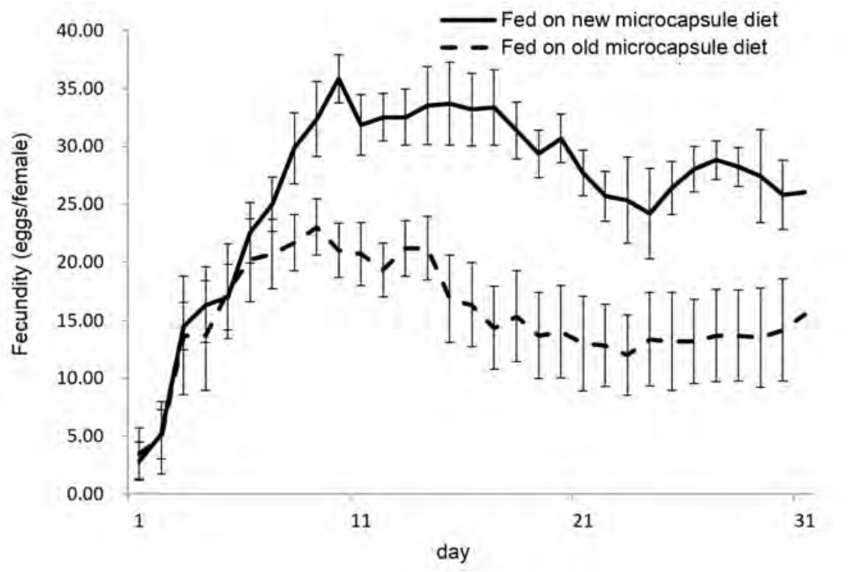

圖 6. 以不同製程之微膠囊飼料飼育之基徵草蛉（*Mallada basalis*）的繁殖力比較。

Fig. 6. Fecundity of *Mallada basalis* (mean number of eggs per female per day) fed with microcapsule diets produced using the old and new encapsulation processes.

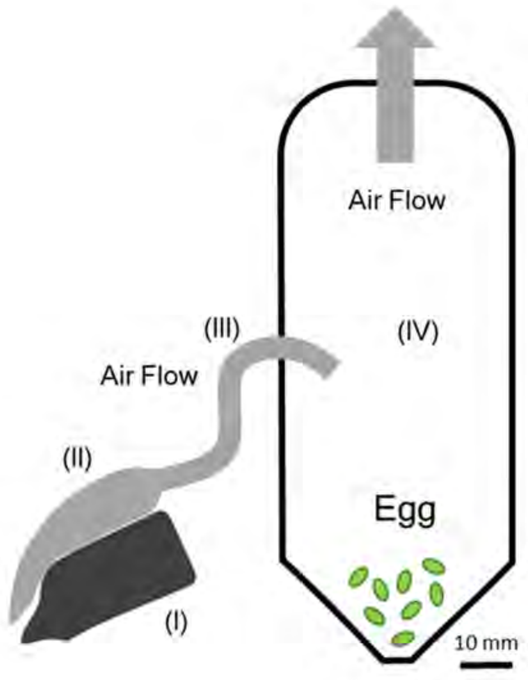

圖 7. 推剪搭配旋風分離器收集基徵草蛉（*Mallada basalis*）卵粒之構造圖。推剪（I）將卵之卵柄切斷，並將卵粒由空氣驅動之收集器（II）將卵吸入至空氣連通管（III），最終卵粒被旋風分離器（IV）收集於底部。

Fig. 7. Diagrams of clipper and cyclonic procedure to take the eggs of *Mallada basalis* from substrate. The clipper (I) removes the egg stalk, and a collector driven by air flow (II) inhale the eggs into

the connecting tube (III), and finally these eggs were transported to cyclonic separator (IV).

圖 8. 推剪搭配旋風分離法收穫的基徵草蛉（*Mallada basalis*）卵。

Fig. 8. Eggs of *Mallada basalis* harvested using a hair clipper with cyclonic separation.

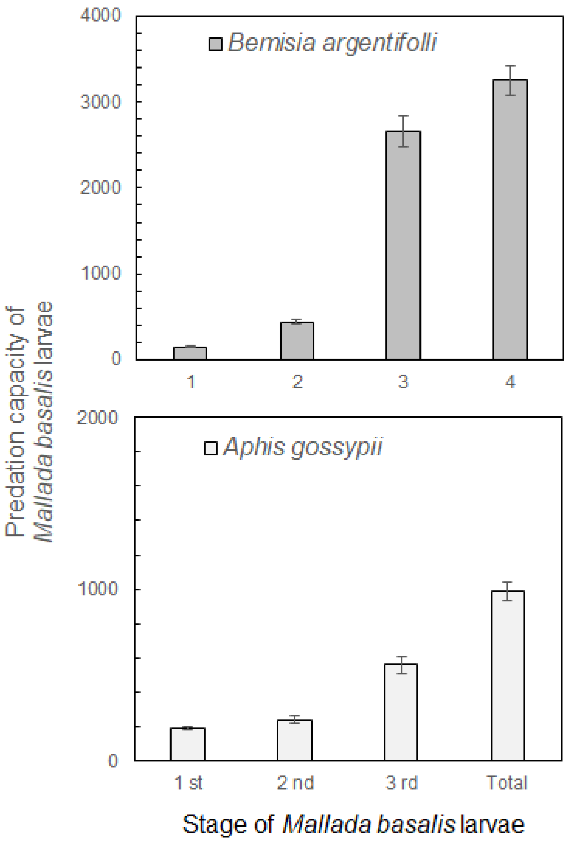

圖 9、基徵草蛉（*Mallada basalis*）幼蟲於不同齡期對二齡棉蚜（*Aphis gossypii*）若蟲以及三齡銀葉粉蝨（*Bemisia argentifoli*）若蟲之捕食量。

Fig. 9. Predation capacity (Mean ± SE) of both lines of *Mallada basalis* larvae on second-stage

Aphis gossypii nymphs and third-stage *Bemisia argentifolli* nymphs.

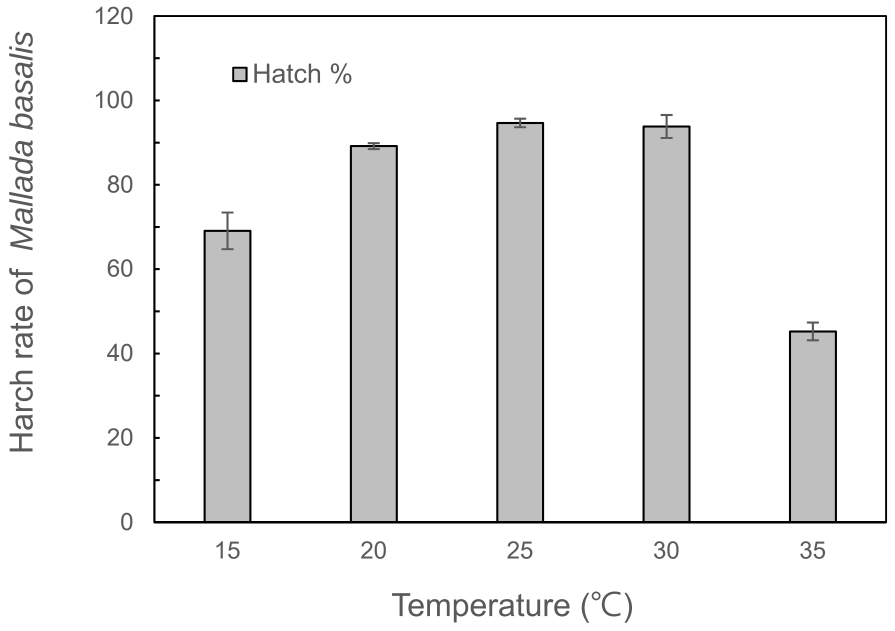

圖 10、基徵草蛉（*Mallada basalis*）卵於不同溫度下的孵化率。

Fig. 10. Hatch rate (Mean ± SE) of *Mallada basalis* eggs on different temperature.

表 1. 飼養草蛉（*Mallada basalis*）之微膠囊飼料新與舊製程之消耗電力、體積、總重、費用及製造能力比較。

Table 1. Power requirements, dimensions, weight, cost, and productivity of equipment used in production of old and new microcapsule diets for rearing *Mallada basalis*.

Item	Old Process	New Process	Reduction (%)
Power requirement (watt in average)	5570.0	2135.0	61.7
Dimension (m^3)	11.8 (2.1 × 2.0 × 2.8)	1.3 (2.4 × 0.6 × 0.9)	89.0
Total weight (kg)	336.0	42.4	87.4
Cost (thousand in USD)	9.4	4.2	55.6
Productivity (kg / hr.) (Diet produced per hour)	2.75	2.75	--

表 2. 不同製程對飼養基徵草蛉（*Mallada basalis*）之新與舊微膠囊飼料直徑及殼厚度之影響。

Table 2. Diameter and thickness of old and new microcapsule diets for rearing *Mallada basalis* using different production methods.

	Old Process (range)	New Process (range)
Diameter (μm)	651.3 ± 19.4 (531.6 - 905.1)	742.1 ± 11.3 ** (626.9 - 857.1)
Thickness (μm)	35.4 ± 4.9 (10.1 - 127.0)	44.2 ± 1.9 (26.1 - 63.2)

Mean ± SE within the row followed by * and ** are significant at the 5% ($P < 0.05$) and 1% ($P < 0.01$) levels, respectively. (*t* test, $P = 0.05$)

表 3. 單隻飼養時的基徵草蛉（*Mallada basalis*）幼蟲食用不同製程之新與舊微膠囊飼料對發育時間與成蟲繁殖力的影響。

Table 3. Development time and adult fecundity of *Mallada basalis* larvae in the single-rearing test fed with microcapsule diets made from different production methods.

Stage	Old microcapsule		New microcapsule	
	Duration (days)	Cumulative survival rate (%)	Duration (days)	Cumulative survival rate (%)
1st -2nd	4.0 ± 0.1	100.0	3.4 ± 0.1 **	100.0
2nd -3rd	4.0 ± 0.1	93.3	3.0 ± 0.0 **	100.0
3rd -pupae	5.1 ± 0.2	93.3	3.9 ± 0.1 **	100.0
Pupae - emerge	10.9 ± 0.1	66.7	10.6 ± 0.2 *	83.3
From instar to adult	24.0 ± 0.3	66.7	20.1 ± 0.6 **	83.3
Adult fecundity (eggs at first 30 days)	465 ± 65.05		678 ± 54.91 *	

Mean ± SE within the row followed by * and ** are significant at the 5% ($P < 0.05$) and 1% ($P < 0.01$) levels,

respectively. (Mann–Whitney *U* testing was applied with $P < 0.05$ for the duration of development and *t* testing was conducted with $P < 0.05$ for the fecundity.)

表 4. 群體飼養時之基徵草蛉 (*Mallada basalis*) 幼蟲食用不同製程之微膠囊飼料對成蟲存活率的影響。

Table 4. Adult survival rates of *Mallada basalis* in the group-rearing test fed with old and new microcapsule diets made from different production methods.

Diet from encapsulation process	Number of larvae in group-rearing	Adult Survival (%)
Old	1000	25.4 ± 1.1
New	1000	44.8 ± 3.0 **

Mean ± SE within the column followed by * and ** are significant at the 5% ($P < 0.05$) and 1% ($P < 0.01$) levels, respectively. (*t* test, $P = 0.05$)

表 5. 推剪法搭配次氯酸鈉溶解法取下基徵草蛉 (*Mallada basalis*) 卵粒之成功率、孵化率及成蟲獲得率。

Table 5. Egg harvest (%), hatch (%), and egg-adult (%) for removing the egg stalk of *Mallada basalis* using the clipper and sodium hypochlorite method.

Method of removing egg stalk		Eggs harvest % (Mean ± SEM[z])	(*Mallada basalis*) Mean ± SEM)	Egg - adult % (Mean ± SEM)
Scissors		100.0 ± 0.0 a[y]	90.8 ± 1.6 a	60.8 ± 0.8 a
Clipper with cyclonic separation	1 mm	90.2 ± 0.6 ab	80.8 ± 2.8 ab	54.2 ± 3.4 ab
	2 mm	63.8 ± 4.8 c	70.8 ± 1.6 b	47.5 ± 1.6 b
	3 mm	45.8 ± 1.8 d	54.2 ± 4.4 c	35.8 ± 1.6 cd
Sodium hypochlorite solution	1.5%, 60 s	80.0 ± 2.3 b	70.0 ± 3.6 b	46.7 ± 4.1 bc
	3.0%, 30 s	80.1 ± 4.7 b	51.7 ± 3.2 c	33.3 ± 3.0 d
	6.0%, 10 s	78.1 ± 5.1 bc	0.3 ± 0.0 d	0.0 ± 0.0 e

[z] SEM: Standard error of the mean.

[y] Mean ± SEM within the same column followed by the same letters are not significantly different at the 5% levels by least significant difference (LSD) test.

表 6. 在不同作物上釋放基徵草蛉 (*Mallada basalis*) 對不同害蟲密度的影響。

Table 6. Effect of *Mallada basalis* releasing on densities of different pest occurred on plant.

Plant	Pest population	Releacing of *Mallada basalis* eggs per plant	releasing time	Pest population rate (%) compared to the control
Carica papaya		100		34.3
(Chen *et al.* 2014)	*Tetranychus kanzawai*	200	8 week	4.6
		300		4.5
		50		27.9
Melissa officinalis	*Tetranychus kanzawai*	100	3 week	16.4
(unpublished data)		200		12.7
Capsicum annuum	*Aphis gossypii*	3	8 week	0.5
(Lu & Wang 2005)	*Bemisia argentifolii*	3	7 week	25

The rearing technique of green lacewing [*Mallada basalis* (Walker)] and the application in environmentally-friendly farming

Pei-Chen Hsu[1], Yew-Jen Dong[1], Wan-Hsiu Yang[1], and Jih-Zu Yu[2 *]

Hsu P. C. [1], Y. J. Dong[1], W. H. Yang[1], and J. Z. Yu[2*]. 2021. The application and future of green lacewing [*Mallada basalis* (Walker)] as a material in environmentally-friendly farming.

Abstract

Green lacewing [*Mallada basalis* (Walker)], also known as aphid lion, are important natural enemies of a variety of small pests. *Mallada basalis* can be mass rearing on artificial feed and they are applicated with great potential in environment-friendly farming system in domestic and foreign countries. Small pests with resistance to pesticides usually cause damage to crops in environmentally friendly agriculture. However, the use of natural enemies of insects as a strategy is appropriate to reduce the cost of using non-chemical materials and improve the efficiency of pest control, without the use of chemically synthesized pesticides. At present, the primary research work is to research and develop labor-saving feeding and breeding technology of lacewings, and the second is to use environmental-friendly materials properly to formulate pest control strategies in facilities. In addition, it is necessary to breed lacewing strains that can withstand extreme climates to meet the climatic conditions of various agricultural areas. Natural materials and natural enemies should be integrated appropriately to pest control and management strategy in a friendly agricultural environment to fulfill the responsibility of protecting the environment.

Key words: *Mallada basalis* (Walker), Environmentally-friendly farming, Integrated pest management.

*Correspondence address
e-mail: jzyu@tari.gov.tw